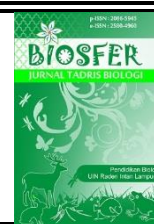




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The Effect of GA3 and Salicylic Acid Combination on the Germination and Growth of Kelinci Variety Peanut Sprouts (*Arachis Hypogaea L.*) Under Aluminum Casting

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ABSTRACT

This research aims to determine the influence of GA3 and salicylic acid on the germination and growth of Kelinci variety peanuts under aluminum casting. This study was conducted in a 2x3 factorial experiment. Factor A is AL(OH)₃ with two concentration levels: 0% b/v and 5% w/v. Factor B is a growing stimulant substance (ZPT) with three levels: GA3 (0.1 % w/v), salicylic acid (0.1% w/v), and GA3 + salicylic acid. The parameters in this study are 1) germinating power, 2) length of sprouts, 3) fresh weight of sprouts, 4) dry weight of sprouts and 5) relative moisture content. The Tukey test determines the main effect, and an F test determines the simple effect. From the research results, the researchers conclude that the mixture of GA3 solution and SA solution is more effective than a single solution of GA3 or SA in overcoming the aluminum's toxic effects on the germination and sprout growth of Kelinci variety peanut.

Perkecambahan dan Pertumbuhan Kecambah Efek Kombinasi GA3 dan Asam Salisilat pada Kacang Tanah (*Arachis Hypogaea L.*) Varietas Kelinci di Bawah Cekaman Aluminium

ABSTRAK: Penelitian ini bertujuan untuk mengetahui pengaruh GA3 dan asam salisilat terhadap perkecambahan dan pertumbuhan kacang tanah varietas kelinci dibawah cekaman aluminium. Penelitian ini dilaksanakan dalam percobaan faktorial 2x3. Faktor A adalah AL(OH)₃ dengan dua taraf konsentrasi : 0% b/v dan 5% b/v. Faktor B adalah Zat Perangsang Tumbuh (ZPT) dengan tiga taraf : GA₃ (0,1 % b/v), asam salisilat (0,1% b/v) dan GA₃ + asam salisilat. Parameter dalam penelitian ini yaitu: 1) daya kecambah, 2) panjang tunas kecambah, 3) berat segar kecambah, 4) berat kering kecambah, dan 5) kadar air relatif. Main effect ditentukan dengan uji Tukey dan simple effect dengan uji F. Dari hasil penelitian disimpulkan bahwa campuran larutan GA3 dan larutan AS lebih efektif dari pada larutan tunggal GA3 atau larutan AS dalam mengatasi efek toksik aluminium terhadap perkecambahan dan pertumbuhan kecambah kacang tanah varietas kelinci.

INTRODUCTION

Peanut is a source of protein for the Indonesian population (Sembiring et al., 2014; Ulhair et al., 2018). It has high economic values as agribusiness commodities (A. Rahayu et al., 2020; SAIRDAMA, 2017). The need for peanuts is increasing from year to year along with the population increase (Ikhsani et al., 2018; Srilestari, 2015), community nutritional needs, food diversification, and the capacity of the feed and food industry in Indonesia (Sembiring et al., 2014; Ulhair et al., 2018). However, the production of peanuts in Indonesia is not sufficient; therefore, peanuts are often imported from abroad (Hermawati, 2018; SE Rahayu & Febriaty, 2019). The government seeks to increase production through plantation are expansion and appropriate fertilizers (Bimasri & Murniati, 2017; Harsono, 2015).

In Indonesia, people have long known peanuts as industrial food (Bekti et al., 2019; Mutia & Saleh, 2016). Peanuts are usually planted in rice fields (moor) in an intercropping system (Dewati et al., 2012; Rahmianna et al., 2015). As food, peanuts contain many fat and protein (Gresinta, 2015; Yulifianti et al., 2015). Peanut production in Indonesia ranks second after soybeans (Faisal, 2021). Peanuts contribute significantly to meeting the needs of legumes (IRMADAMAYANTI et al., 2019; Mayura & Idris, 2019). Peanuts also contain 25-30% protein, 40-50% fat, 12% carbohydrates, and vitamin B1 (Reiza et al., 2017). The nutritional contents ranked second after soybean (Ambarsari et al., 2019; Aslamiah & Sularno, 2018; Sembiring et al., 2014; Silawibawa et al., 2020; Susilo, 2018). In the industrial sector, peanuts are helpful to produce margarine, soap, cooking oil, and many other products (A. Rahayu et al., 2020).

Select varieties can increase production (Beding & Tiro, 2020; Hendrawati & Erlinda Yurisnthae, 2014) and improve technical cultures regarding plant care, proper fertilization, and drainage systems. Declining peanuts production might be caused by the inability of the gynophores to enter the soil, causing the pods-forming failure (Hadi, 2019). Salicylic acid is an essential inducer of plants' disease resistance (Noviantia et al., 2017). Salicylic acid can fight off pathogen attacks as a form of defense (Harni et al., 2013; Tistama & Dalimunthe, 2018). Also, plants can naturally produce salicylic acid (Darmanti, 2018; Illing et al., 2017). Salicylic acid is a phenolic compound with a tolerance effect on abiotic stress (Darmanti, 2018; Soesanto & Rahayunia, 2010).

Research on the effect of GA3 and salicylic acid combination on the germination and sprout growth has been carried out to see the effect of coconut water (Nopiyanti & Dwiriasuti, 2018), the salinity stress (Kristiono & Taufiq, 2014), the effect of phosphate solubilizing bacteria (Avivi et al., 2010), and the response of organic waste (Fitriani et al., 2020). Previous studies were limited to different responses and effects. However, this research focuses on the effect of GA3 and salicylic acid combination on Kelinci variety peanut (*Arachis Hypogaea L.*) under aluminum casting. Based on this reason, this research analyzed the effect of GA3 and salicylic acid combination on the germination and sprout growth of Kelinci variety peanut (*Arachis Hypogaea L.*) under aluminum casting.

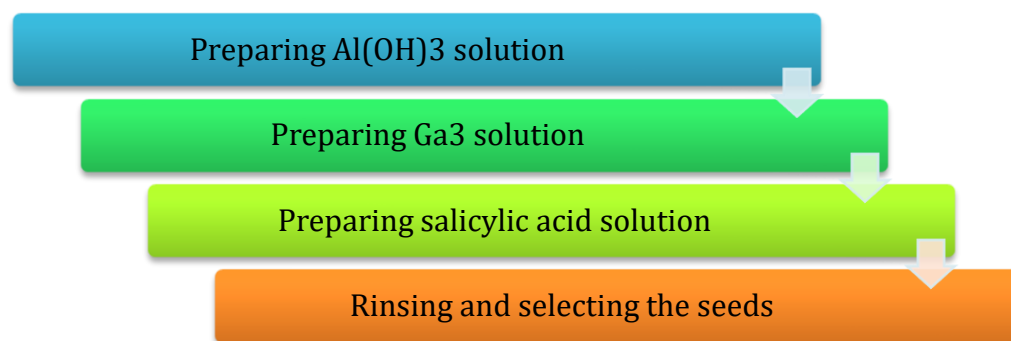
The researchers analyzed the effect of GA3 and salicylic acid combination on the germination and sprout growth of Kelinci variety peanut (*Arachis Hypogaea L.*) under aluminum

casting. Each treatment combination was repeated four times so that the number of experimental units consisted of 24 times. This research is essential to determine the effect of GA3 and salicylic acid combination on germination and growth of Kelinci variety peanut under aluminum casting.

RESEARCH METHODOLOGY

The researchers conducted this research at the Botanical Laboratory, Faculty of Mathematics and Natural Sciences, the University of Lampung from November to December 2018. The tools used in this study were plastic trays, plastic cups, filter paper, labels,

tissue, rubber bands, plastic, beaker glass, Erlenmeyer, measuring cup, volume pipette, dropper, test tube, mortar and grinder rack, digital scale, centrifuge, oven, UV spectrophotometer, knife, scissors, and ruler. The materials used in this study were peanuts obtained from the Seed Center of Lampung Province, Al(OH)₃, gibberellin hormone (GA₃), salicylic acid, alcohol, and distilled water. This research employed a 2x3 factorial experimental design. Factor A was Al(OH)₃ with the concentration levels of 0% w/v and 0.5% w/v. Factor B is a growth-stimulating substance (ZPT) with concentration levels of GA₃ (0.1% w/v), salicylic acid (0.1% w/v), and GA₃ + salicylic acid.



Picture 1. Step research experiment.

After this stage, the floating seeds and waste were removed, while the sinking seeds were taken for germination. The selected seeds were then soaked in three concentration levels, namely GA₃, salicylic acid, and the mixture of GA₃+Salicylic acid. Another three levels of Al(OH)₃ concentrations, namely Al(OH)₃ 5% w/v + GA₃, Al(OH)₃ 5% w/v + Salicylic Acid, and Al(OH)₃ 5% w/v + GA₃ + Salicylic Acid for 24 hours. The soaked peanut seeds were placed in six plastic bags lined with tissue and moistened with distilled water for germination. There were 600 seeds with 100 seeds in

each tray. Forty-eight germinated seeds with normal growth were selected. The containers used for the growth of sprouts were plastic cups. A total of 24 plastic cups were washed and wiped dry. The plastic cups were labeled with the combination of treatment and replication notation.

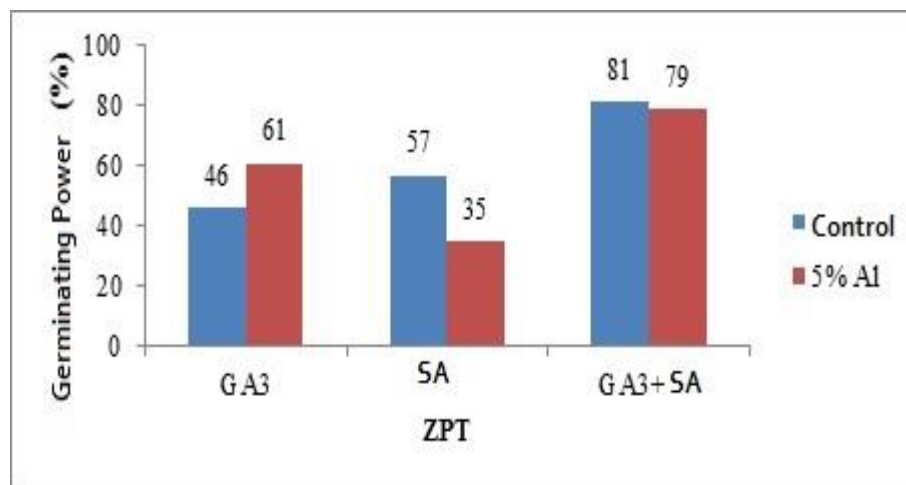
Next, the plastic cups were lined with tissue and filter paper and moistened with 0.1 ml of GA₃, 5 ml of salicylic acid, a mixture of 0.1 ml of GA₃, and a mixture of 0.1 ml of salicylic acid. Every two sprouts were put into a plastic cup. The germination variables were observed seven days after the

treatment. The researchers measured the sprout length by measuring the base to the tip with a ruler (cm). In measuring the fresh weight, the researchers weighed the sprouts using a digital balance (mg). Furthermore, the researchers measured the dry weight after drying the sprouts in an oven for 2 hours at a temperature of 130°C to remove the moisture content in the

sprouts. The sample was weighed and expressed in milligrams (mg).

RESULTS AND DISCUSSION

The effect of salicylic acid, GA3, and the combination of salicylic acid and GA3 on the germination of Kelinci variety peanuts under aluminum hydroxide casting is shown in Figure 2.



Picture 2. The Germinating Power of Kelinci Variety Peanut at Various Concentrations of Salicylic Acid, GA3, and Salicylic Acid + GA3.

Aluminum toxicity is one of the primary plant growth and development inhibiting factors in many acidic soils. The plasma membranes of root cells, especially the apex, appear to be the main target of Al toxicity. The strong interaction of Al³⁺ (the toxic form of Al) with oxygen donor ligands (proteins, nucleic acids, and polysaccharides) inhibits cell division, cell extension, and cell transportation (Manpaki et al., 2017). This research found that GA3+SA was more effective in promoting seed germination under normal growth conditions than salicylic acid and GA3 individually. Likewise, SA was more effective than GA3 in fostering the germination of Kelinci variety peanuts. Under aluminum casting, GA3 + SA was more effective than SA and GA3 in promoting the germination of Kelinci

variety peanuts. GA3 was more effective than SA in promoting Kelinci peanut seed germination.

The success of seed germination depends on two critical physiological processes: the absorption of water by the seed (imbibition) and the hydrolysis of starch into glucose as the primary substrate in the respiration process (Kartawijaya, 2014). The hydrolysis of starch is catalyzed by the amylase enzyme, while glucose is the primary energy source for the germination process (MARDAWATI, 2019; Risnoyatningsih, 2012). Simple effect analysis showed that in the GA3 treatment, Al(OH)₃ decreased the average sprout length. Then, there was no significant average sprout length difference in the salicylic acid treatment

between the control and Al(OH)₃. Likewise, at the GA3 + AS level, there was no significant difference in the

average sprout length between the control and Al(OH)₃.

Table 1. The Simple Effect of Al(OH)₃ at Each Level of ZPT on Sprout Length of Kelinci Peanut Variety

	ZPT			
	level	GA3	SA	GA3 + SA
Al(OH) ₃	Control	4.25a ± 0.57	4.88a ± 0.54	4.075a ± 0.22
	0.5%	2.75a ± 0.32	4.23a ± 0.144	4.80a ± 0.43

Information: HSD 0.05 cells = 1.82. The values followed by the same letter in the same column were not significantly different at the 5% significance level.

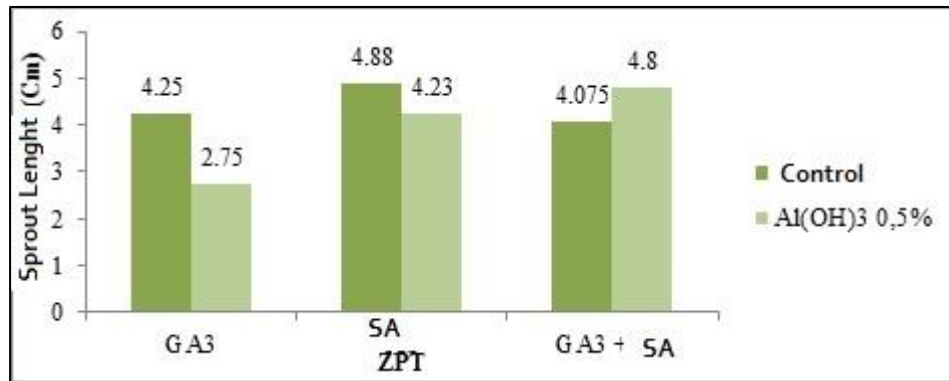


Figure 3. The simple effect of Al(OH)₃ at each level of ZPT on Sprout Length of Kelinci Variety Peanut

The effect of salicylic acid, GA3, and the combination of salicylic acid and GA3 on the sprout length of Kelinci variety peanut under aluminum hydroxide casting is shown in Figure 2. Levene test at 5% significance level indicated that the population variance

was homogeneous ($p > 0,05$). The analysis of variance at a 5% significance level showed that aluminum had no significant effect on sprout length while ZPT had a significant effect on sprout length. The aluminum and ZPT had a significant effect on sprout length.

Table 2. The simple effect of ZPT at Every level of Al(OH)₃ on Sprout Length of Peanut Sprouts

	ZPT			
	level	GA3	SA	GA3 + SA
Al(OH) ₃	Control	4.25a ± 0.57	4.88a ± 0.54	4.075a ± 0.22
	0.5%	2.75a ± 0.32	4.23ab ± 0.144	4.80b±0.43

Information: HSD 0.05 Cell = 1.82. The values followed by the same letter in the same row are not significantly different at the 5% significance level.

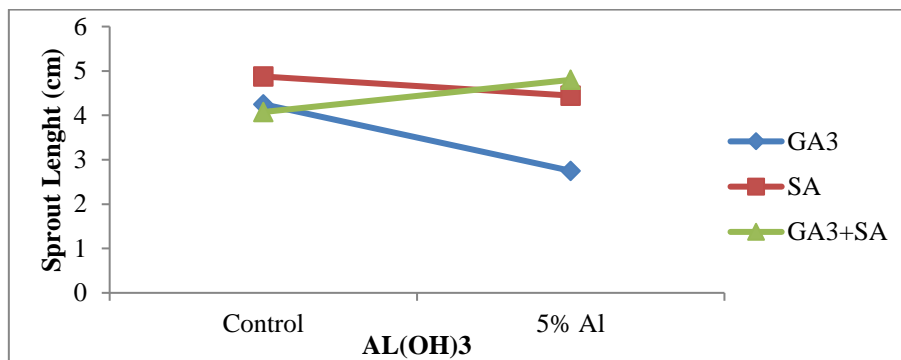


Figure 4. The Interaction Curve between ZPT and AL(OH)3 on Sprout Length

The interaction between Al(OH)3 and GA3 and salicylic acid decreases the average sprout length of peanut sprouts. On the other hand, the interaction between Al(OH)3 tends to increase the sprout length. The effect of salicylic acid,

GA3, and the combination of salicylic acid and GA3 on the fresh weight of Kelinci variety peanuts under the stress of aluminum hydroxide is shown in Figure 5.

Table 3. The Simple Effect of ZPT at Every Level of Al(OH)3 on Fresh Weight of peanut Sprout

		ZPT		
		GA3	SA	GA3 + SA
Al(OH)3	Level			
	Control	0.815	1,198	0.895
	Al(OH)3 0.5%	0.864	1,728	0.955
Marginal mean		0.839a	1.463b	0.925ac

Information: HSD 0.05 column = 0.32

The Levene's test at a 5% significance level showed that ZPT had a significant effect on the fresh weight of sprouts, while Al(OH)3 and its

interaction with ZPT did not significantly affect the fresh weight sprouts.

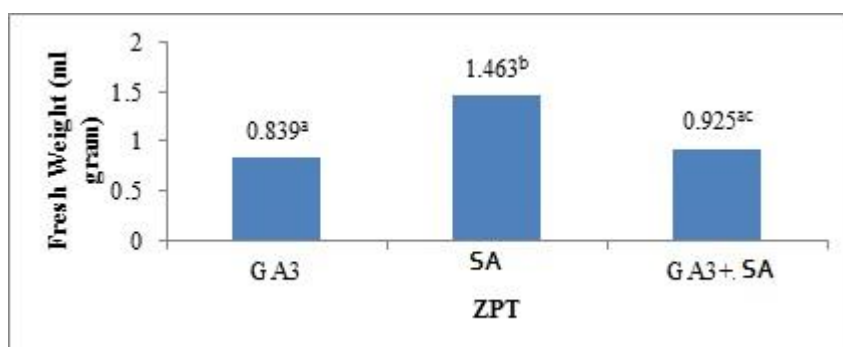


Figure 5. The Main Effect of ZPT on Fresh Weight of Kelinci Variety Peanut Sprout

The main effect analysis showed that the response of peanut sprouts to

GA3, salicylic acid, and GA3 + salicylic acid was relatively different. Salicylic

acid had a higher stimulating effect than GA3 and GA3 + salicylic acid. The fresh weight of sprouts was determined by the dry weight and relative moisture content of the sprouts. The roots' rate of water absorption and the leaves' transpiration rate determine the fresh weight of sprouts. The allocation of food reserves from seeds or endosperm

determines the dry weight of the plant. The results showed that the ZPT effect did not depend on growing conditions. The fresh weight of sprouts was relatively the same under normal growth conditions and aluminum casting. SA was relatively better in stimulating roots' water absorption than GA3 and GA3+SA.

Table 4. Average Dry Weight of Kelinci Variety Peanut Sprouts

	ZPT			
	Level	GA3	SA	GA3 + SA
Al(OH)3	Control	0.251 ± 0.055	0.286 ± 0.020	0.260 ± 0.025
	Al(OH)3 0.5%	0.328 ± 0.065	0.371 ± 0.067	0.294 ± 0.048

Levene's test at a 5% significance level shows that the population variance was homogeneous. Uniform analysis at a 5% significance level showed that the interaction between ZPT and Al(OH)3

posed no significant effect. The effect of ZPT and its interaction with Al(OH)3 on the relative moisture content of peanut sprouts are shown in table 5.

Table 5. The Average Relative Moisture Content of Kelinci Variety Peanut Sprouts

	ZPT			
	Level	GA3	US	GA3 + US
Al(OH)3	Control	70.0 ± 5.5	73.8 ± 5.1	70.7 ± 3.1
	Al(OH)3 0.5%	63.0 ± 4.0	77.2 ± 5.7	69.2 ± 3.7

Levene's test at a 5% significance level shows that the population variance was homogeneous. Uniform analysis at a 5% significance level showed that the interaction between ZPT and Al(OH)3 posed no significant effect. Aluminum casting did not affect the dry weight and relative moisture content of peanut sprouts. Therefore, the possibility of aluminum toxicity did not affect the allocation of food reserves. Likewise, the same phenomenon was found in the relative water content.

The germination and sprout growth under aluminum casting did not affect the dry weight and moisture content.

The effect of GA3 and salicylic acid combination on Kelinci variety peanut (*Arachis Hypogaea L.*) under Aluminum casting shows that GA3 was more effective than SA in encouraging Kelinci variety peanut sprouts growth. Based on this research, peanut seed germinating power depends on two physiological processes, namely the hydrolysis of starch into glucose as the primary substrate in the respiration process. (Kartawijaya, 2014). Besides, in the GA3 treatment, Al(OH)3 decreased the average sprout length. Furthermore, there was no significant average sprout length difference in the salicylic acid

treatment between the control and Al(OH)₃.

CONCLUSION

Based on the research results, the mixture of GA₃ solution and SA solution was more effective than a single solution of GA₃ or SA solutions in overcoming the toxic effect of aluminum on germination and growth of Kelinci variety peanut sprouts. Therefore, the researchers suggest that to germinate peanut seeds, physiological processes and hydrolysis are needed in providing the best concept before the material is researched. Furthermore, the effect of GA₃ and salicylic acid combination must be carefully assessed and observed on the sprout growth and germination of Kelinci variety peanuts.

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